

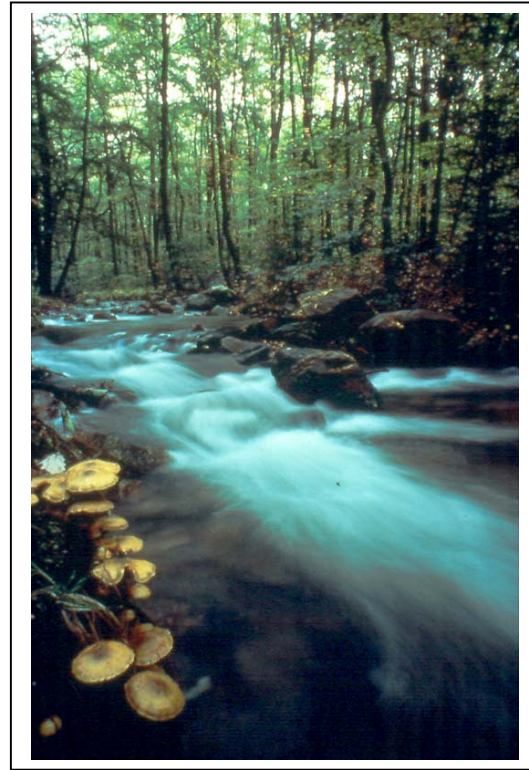
Stream and River Habitats:

(23) *Coldwater Streams*

Description:

Coldwater streams comprise approximately 1500 miles of Maryland's freshwater streams and are unique in their form, function, and biota. They are most common in the Highlands physiographic province, particularly in the Youghiogheny drainage, but are also found in the Piedmont physiographic province within the Middle Potomac, Susquehanna, Gunpowder, and Patapsco drainages.

Characterized by a maximum daily mean water temperature of less than 22°C and dissolved oxygen levels greater than 5 mg/L, these streams are typically found only in the headwater reaches of a watershed. Most are riffle-dominated, high gradient (>2%) streams with well-shaded riparian canopies allowing for mechanical aeration and regulation of water temperature. Compared to downstream cool- and warmwater streams, aquatic biodiversity and productivity are low, with few fish and benthic macroinvertebrate species, often



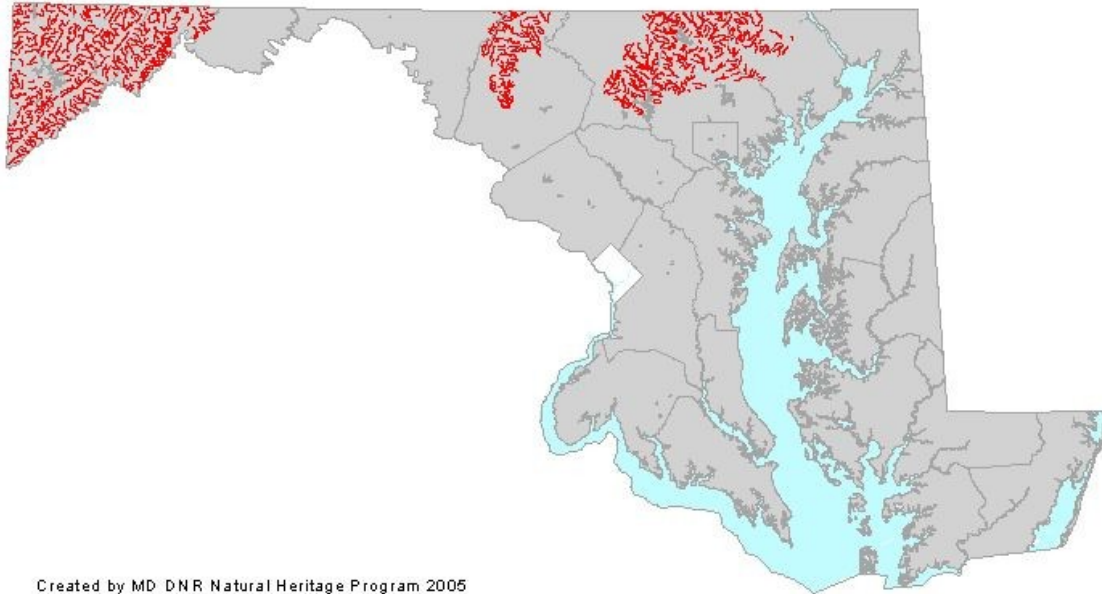
occurring in low abundance. Brook trout, Maryland's only native trout species, are found in these streams along with introduced brown and rainbow trout. Common non-game species include mottled and Blue Ridge sculpin, tessellated darter, longnose dace, and creek chub. Stoneflies along with mayflies of the genera *Ephemerella*, *Epeorus*, *Stenonema*, and *Paraleptophlebia* often dominate the benthic macroinvertebrate community. In contrast to the low diversity of fish and benthic macroinvertebrate species, coldwater streams support the greatest diversity of aquatic and semi-aquatic salamanders in the State, including spring, seal, and mountain dusky salamanders.

Location and Condition:

Coldwater stream habitats have declined as a result of disturbance associated with agriculture and urban development. Although the historic extent of coldwater streams in Maryland is not known, this type of stream was likely more widespread. Based on a Combined Biotic Index (CBI) that uses fish and benthic macroinvertebrate communities as indicators of environmental quality, coldwater streams in Maryland are in fair condition, meaning that many of these streams are at least partially degraded. Of 143 sites sampled in coldwater streams from 2000-2004, 34% are considered to be severely degraded. Twenty-eight percent of sites sampled during this period are considered to be in good condition. A predictive model developed by Maryland DNR estimates that, on average, 33% of fish species have

been lost from Maryland's coldwater systems. The decline of the brook trout, a GCN coldwater stream species, in Maryland occurs at relatively low levels (approximately 5%) of impervious surfaces in a watershed. Higher stream temperatures and increased sedimentation are likely explanations for the loss of fish species from coldwater streams.

Figure 4.23 Location of Coldwater Streams in Maryland (Source: MD DNR MBSS/Versar Inc.)



GCN Species and Other Wildlife:

Mammals	Redside dace	Ocellated darter
Southern water shrew	Silverjaw minnow	River jewelwing
Reptiles	Inverts: Dragonflies & Damselflies	Sable clubtail
Common ribbonsnake	Arrowhead spiketail	Ski-tailed emerald
Queen snake	Brown spiketail	Southern pygmy clubtail
Wood turtle	Common sanddragon	Spine-crowned clubtail
Amphibians	Delta-spotted spiketail	Superb jewelwing
Allegheny Mountain dusky salamander	Great spreadwing	Tiger spiketail
Long-tailed salamander	Green-faced clubtail	Turquoise bluet
Northern red salamander	Harpoon clubtail	Zebra clubtail
Seal salamander	Least clubtail	Inverts: Freshwater Crustaceans
Fishes	Midland clubtail	An entocytherid ostracod
Brook trout	Mocha emerald	An entocytherid ostracod
Mottled sculpin	Northern pygmy clubtail	

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, northern river otter, American beaver, muskrat, wood duck, eastern

snapping turtle, brook trout, brown trout, rainbow trout, cutthroat trout, and white sucker. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Non-native species
- g. Nutrient enrichment
- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Loss of headwater areas
- k. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- l. Dumping
- m. Development and land use, including roadways, that result in fragmentation and isolation
- n. Deforestation that results in loss of forested watershed
- o. Human recreation that results in disturbance/degradation
- p. Point-source pollution
- q. Incompatible timber harvesting that results in loss of coarse woody debris and increased water temperatures
- r. Stream flow alteration from culvert placement
- s. Erosion
- t. Recreational use that results in degradation of habitat
- u. Acid mine drainage
- v. Roads, including maintenance, and ATVs
- w. Degradation due to livestock grazing
- x. Overabundance of deer as it impacts the regeneration of trees adjacent to streams

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- c. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- d. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- e. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- f. **Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such** *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*
- g. **Preserve land associated with streams** *[Measure: # of acres conserved]*

- h. Work with Maryland DOT to minimize use of road culverts or to design better systems to reduce stream alterations *[Measure: # of guidelines developed; # of new road plans with guidelines implemented]*
- i. Establish passage at existing stream blockages or remove existing stream blockages completely where appropriate *[Measure: # of passages established; # of blockages removed]*
- j. Minimize acid mine drainage and mitigate damages resulting from such drainage *[Measure: # of guidelines and protocols developed; # of sites with protocols implemented]*
- k. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors]*
- l. Work with Army Corps of Engineers and federal, state and county highways to reduce impacts and improve mitigation targeting *[Measure: # of guidelines developed; # of new road plans with guidelines implemented; # of mitigation projects implemented]*
- m. Upgrade existing use classification through MDE process *[Measure: use classification upgraded]*
- n. Develop and implement protocols to control deer populations to reduce browsing levels in riparian buffers *[Measure: # of protocols developed; # of sites with management implemented]*
- o. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- p. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- q. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- r. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- s. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- t. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with mechanisms to minimize impacts]*
- u. Reforestation of watersheds *[Measure: # of acres reforested]*
- v. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- w. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*

Inventory, Monitoring and Research Needs:

- a. Define the complete extent of distribution of coldwater stream habitats *[Measure: distribution of coldwater streams updated; habitat model developed and assessed]*
- b. Assess coldwater stream habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- c. Initiate long-term monitoring studies of GCN species, including native brook trout, fishes, and amphibians *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Conduct research on basic ecology, breeding parameters, and life histories of GCN species *[Measure: # of research projects conducted; # of research papers published]*
- e. Conduct research on habitat use and requirements of GCN species *[Measure: # of research projects conducted; # of research papers published]*
- f. Conduct species surveys and determine distribution and abundance of GCN species, including benthic macroinvertebrates and crayfish *[Measure: # of surveys completed]*
- g. Conduct research to determine movement patterns and dispersal of GCN species, especially amphibians *[Measure: # of research projects conducted; # of research papers published]*
- h. Reintroduce GCN species, such as brook trout, into suitable restored habitats *[Measure: # of sites with reintroduction implemented; # of viable populations established]*

(24) Limestone Streams

Description:

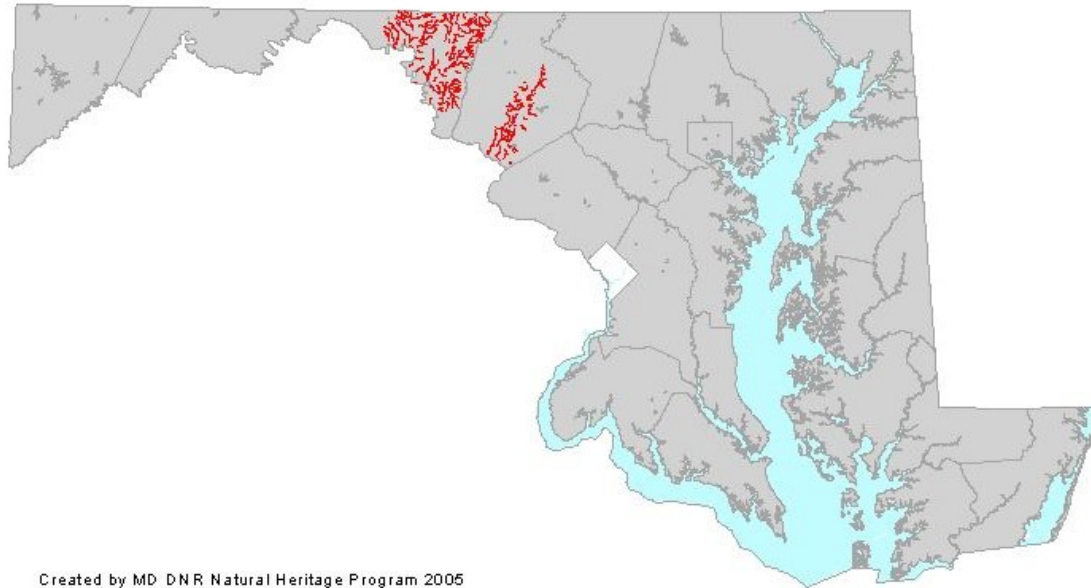
Limestone streams are strongly influenced by the underlying geology of the Ridge and Valley physiographic province of Maryland, resulting in systems that are physically and chemically distinct from freestone (non-limestone) streams. Fractures, cracks, and channels are abundant in limestone making springs and seeps common. This connectivity between groundwater and surface water serves to stabilize pH and water temperature. Limestone streams are also biologically unique. Plants, such as watercress and waterweed are abundant, especially near spring sources and groundwater seeps. Fish and benthic macroinvertebrate communities tend to exhibit low diversity, but maintain high abundance in response to the stable water chemistry. Common fish species include checkered sculpin, pearl dace, and spottail shiner. In contrast to the region's freestone streams, which are dominated by mayfly and stonefly taxa, the benthic macroinvertebrate communities of limestone streams tend to be dominated by crustaceans, like scuds and aquatic sow bugs. An estimated 480 miles of Maryland's streams are limestone systems.



Location and Condition:

The majority of Maryland's limestone streams are located in the Ridge and Valley physiographic province, a predominately agricultural area that is under increasing pressure from suburban development. Agricultural land use practices have altered many of these streams. Based on a Combined Biotic Index (CBI) that uses fish and benthic macroinvertebrate communities as indicators of environmental quality, the average condition of Limestone streams in Maryland is poor. Of 30 sites sampled in limestone streams from 2000 to 2004, 63% are severely degraded. The remaining 37% of sites sampled are moderately degraded. No sites sampled in limestone streams during the five-year period are considered to be in good condition. A predictive model developed by Maryland DNR estimates that, on average, 47% of fish species have been lost from Maryland's limestone stream habitats.

Figure 4.24 Location of Limestone Streams in Maryland (Source: MD DNR MBSS/Versar Inc.)



GCN Species and Other Wildlife:

Reptiles
Common ribbonsnake
Queen snake
Amphibians
Long-tailed salamander
Northern red salamander
Fishes

Brook trout
Checkered sculpin
Pearl dace
Inverts: Dragonflies & Damselflies
Great spreadwing
Least clubtail
Mocha emerald

Turquoise bluet
Inverts: Freshwater Crustaceans
An entocytherid ostracod
An entocytherid ostracod

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, American beaver, muskrat, wood duck, eastern snapping turtle, brook trout, brown trout, rainbow trout, smallmouth bass, redbreast sunfish, and bluegill. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- Urban land use and impervious surface that result in chemical and hydrologic changes
- Sedimentation
- Removal or degradation of riparian buffers
- Atmospheric deposition
- Fragmentation, degradation, and loss of habitats
- Non-native species
- Nutrient enrichment

- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Loss of headwater areas
- k. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- l. Dumping
- m. Development and land use, including roadways, that result in fragmentation and isolation
- n. Deforestation that results in loss of forested watershed
- o. Human recreation that results in disturbance/degradation
- p. Point-source pollution
- q. Groundwater withdrawal
- r. Degradation of seepage wetlands
- s. Strip mining and acid mine drainage
- t. Sink hole pollution/disturbance as it impacts water quality in the stream
- u. Development as it impacts water supply
- v. Ground water contamination which ultimately contaminates surface water
- w. Sewage treatments

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit groundwater withdrawals** *[Measure: # of sites with reduced groundwater withdrawals]*
- c. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- d. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- e. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- f. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- g. Work with Army Corps of Engineers and federal, state and county highways to reduce impacts and improve mitigation targeting *[Measure: # of guidelines developed; # of new road plans with guidelines implemented; # of mitigation projects implemented]*
- h. Prevent degradation of seepage wetlands *[Measure: # of acres protected]*
- i. Implement best management practices for livestock grazing *[Measure: # of projects implementing BMPs]*
- j. Improve capacity for eliminating spills (i.e. TMDL) *[Measure: # of protocols developed]*
- k. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors established]*
- l. Establish passage at existing stream blockages or remove blockages completely where appropriate *[Measure: # of passages established; # of blockages removed]*
- m. Incorporate TMDL process *[Measure: # of processes incorporated into conservation actions]*
- n. Describe and evaluate ground water withdrawals (MDE) *[Measure: # of groundwater withdrawal sites evaluated]*
- o. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- p. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- q. Implement soil conservation *[Measure: # of projects implementing BMPs]*

- r. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- s. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- t. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with mechanisms to minimize impacts]*
- u. Reforestation of watersheds *[Measure: # of acres reforested]*
- v. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- w. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*
- x. Control or limit the introduction of non-native species *[Measure: # of controls implemented]*

Inventory, Monitoring and Research Needs:

- a. Define the complete extent of distribution of limestone stream habitats *[Measure: distribution of limestone stream habitat updated; habitat model developed and assessed]*
- b. Assess limestone stream habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- c. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- d. Monitor existing GCN species populations, including checkered sculpin, so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring projects conducted]*
- e. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- f. Reintroduce certain GCN species into suitable restored habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*
- g. Monitor ecological integrity of hydrological systems *[Measure: # of monitoring studies established]*
- h. Map hydrological systems *[Measure: # of maps developed]*

(25) Highland Streams

Description:

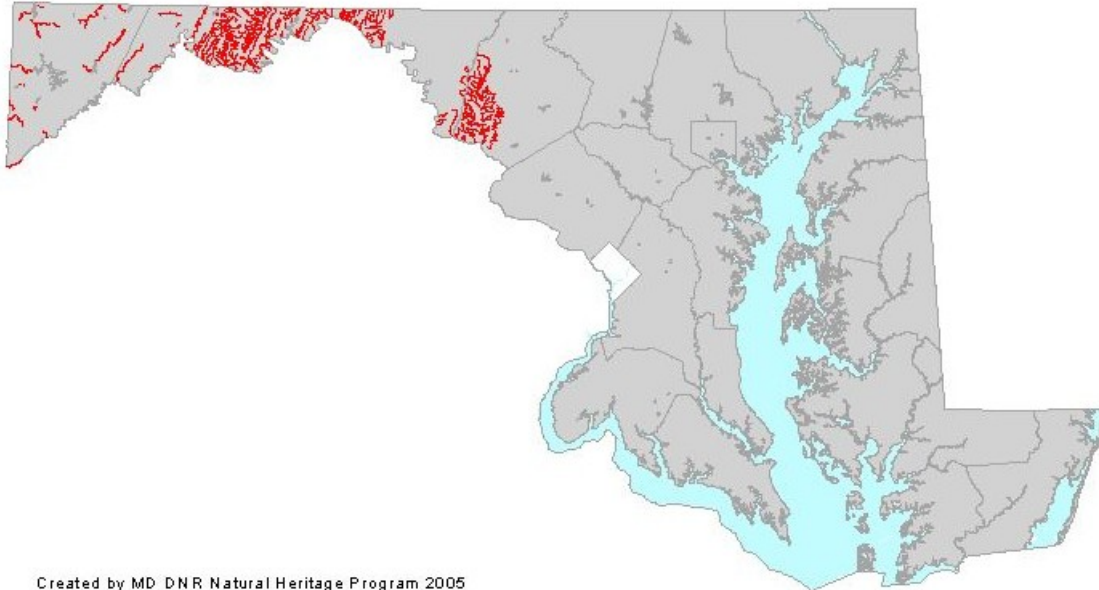
Highland streams flow through several physiographic regions, including the Appalachian Plateau, Valley and Ridge, Blue Ridge, and the western part of the Piedmont. They are typically high gradient systems (>4 %), ranging in elevation from 140 to 2800 feet. Substrate is dominated by gravel-cobble-boulder associations, and is interspersed with bedrock outcroppings. Because many of these streams fall within the rain shadow of the Appalachians, they receive the lowest annual rainfall amounts in the state. Consequently, stream flow in the summer is often markedly reduced for many highland streams. These systems are moderately productive but are home to several endemic fish species, including stonecat, striped shiner, and Johnny darter. These species are found only in the Youghiogheny river basin, which flows to the Mississippi river and ultimately to the Gulf of Mexico. Other common native fish species include mottled and Potomac sculpin. Stoneflies along with mayflies of the genera *Ephemerella*, *Epeorus*, *Stenonema*, and *Paraleptophlebia* often dominate the benthic macroinvertebrate community. Streamside trees and logs play an important role in shaping Highland stream channels and banks, creating pools and slow-water areas beneficial to aquatic species. Logs and leaf litter are also a primary source of organic matter forming the base of the food web in these streams. There are approximately 700 miles of Highland streams in Maryland



Location and Condition:

Based on a Combined Biotic Index (CBI) that uses fish and benthic macroinvertebrate communities as indicators of environmental quality, the average condition of highland streams in Maryland is fair, meaning that many of these streams are at least partially degraded. Of 86 sites sampled in highland streams from 2000-2004, 44% are severely degraded. Only 21% of the sites sampled in highland streams during the same five-year period are considered to be minimally impaired. A predictive model developed by Maryland DNR estimates that, on average, 31% of fish species have been lost from Maryland's highland stream habitats.

Figure 4.25 Location of Highland Streams in Maryland (Source: MD DNR MBSS/Versar Inc.)



GCN Species and Other Wildlife:

Reptiles	Striped shiner	Ski-tailed emerald
Common ribbonsnake	Inverts: Dragonflies & Damselflies	Southern pygmy clubtail
Eastern spiny softshell	Allegheny river cruiser	Spine-crowned clubtail
Queen snake	Arrowhead spiketail	Superb jewelwing
Wood turtle	Cobra clubtail	Turquoise bluet
Amphibians	Cyrano darner	Uhler's sundragon
Allegheny Mountain dusky salamander	Delta-spotted spiketail	Zebra clubtail
Long-tailed salamander	Great spreadwing	Inverts: Beetles
Northern red salamander	Green-faced clubtail	Appalachian Tiger Beetle
Seal salamander	Harpoon clubtail	Inverts: Freshwater Crustaceans
Fishes	Laura's clubtail	An entocytherid ostracod
Brook trout	Least clubtail	An entocytherid ostracod
Cheat minnow	Midland clubtail	Inverts: Freshwater Mussels
Comely shiner	Mocha emerald	Atlantic spike
Greenside darter	Northern pygmy clubtail	Brook floater
Johnny darter	Ocellated darner	Creeper
Longnose sucker	Rapids clubtail	Eastern lampmussel
Northern hogsucker	River jewelwing	Green floater
Silverjaw minnow	Sable clubtail	Triangle floater

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, northern river otter, American beaver, muskrat, wood duck, eastern

snapping turtle, brook trout, brown trout, rainbow trout, and white sucker. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Non-native species
- g. Nutrient enrichment
- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Loss of headwater areas
- k. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- l. Dumping
- m. Development and land use, including roadways, that result in fragmentation and isolation
- n. Deforestation that results in loss of forested watershed
- o. Human recreation that results in disturbance/degradation
- p. Point-source pollution
- q. Acid mine drainage
- r. Incompatible timber harvest practices that result in loss of coarse woody debris and increased water temperatures
- s. Livestock and grazing practices that degrade water quality
- t. Stream channelization

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Minimize or eliminate stream channelization (e.g. culverts)** *[Measure: # of culverts and other stream channelization sites mitigated or eliminated; # miles natural stream flow restored]*
- c. **Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such** *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*
- d. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- e. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- f. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- g. **Minimize and mitigate acid mine drainage damage to streams** *[Measure: # of guidelines and protocols developed; # of sites with protocols implemented]*
- h. **Implement best management practices for livestock grazing near streams** *[Measure: # of projects implementing BMPs]*
- i. **Establish passage at existing stream blockages or remove blockages completely where appropriate** *[Measure: # of passages established; # of blockages removed]*

- j. Develop land management plans which incorporate conservation measures into the local planning processes *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- k. Work with Army Corps of Engineers and federal, state and county highways to reduce impacts and improve mitigation targeting *[Measure: # of guidelines developed; # of new road plans with guidelines implemented; # of mitigation projects implemented]*
- l. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors established]*
- m. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- n. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- o. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- p. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- q. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- r. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with mechanisms to minimize impacts]*
- s. Reforestation of watersheds *[Measure: # of acres reforested]*
- t. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- u. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*

Inventory, Monitoring and Research Needs:

- a. Assess highland stream habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- b. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- c. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- e. Reintroduce certain GCN species into suitable restored habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*

(26) Piedmont Streams

Description:

Piedmont streams, defined by their western boundary of the Catoctin Mountains in Frederick County to the eastern border at the fall line, are among the most biologically productive systems in the State.

The physical and chemical nature of Piedmont streams is governed largely by the varying topography and geology of the Piedmont physiographic province. Streams along the eastern edge share similar physical characteristics with the

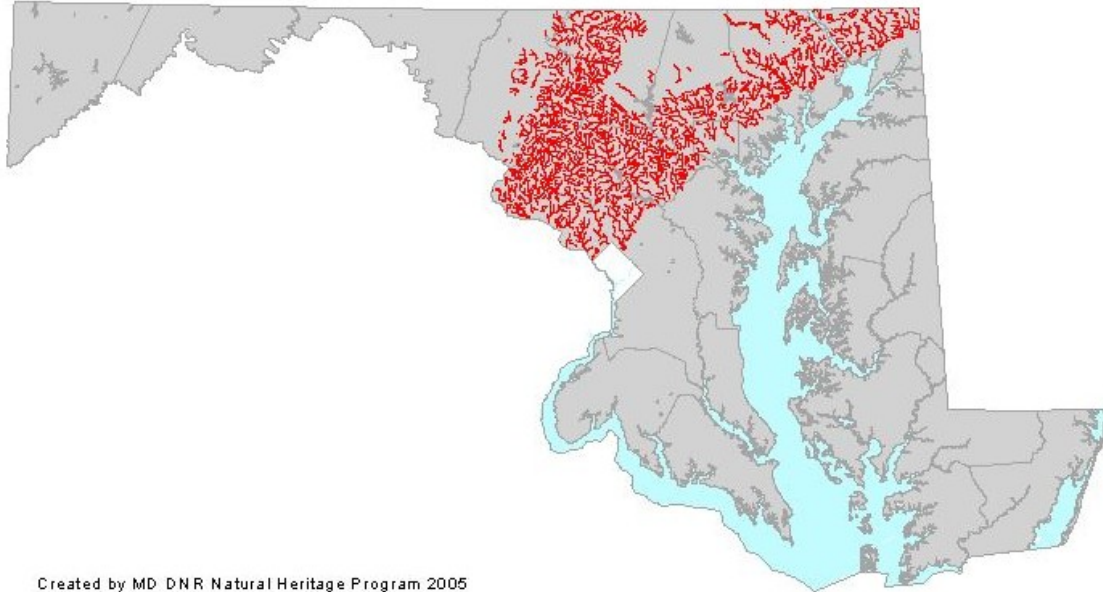


neighboring Coastal Plain. Here, streams are typically low to moderate gradient (1-2%) with silt, sand, and gravel substrates common. Juxtaposition of these two physiographic provinces results in a mixing of aquatic biota, with several predominately Coastal Plain species commonly found within Piedmont streams draining this transition zone. Fish species common to these streams include tessellated darter, eastern blacknose dace, common shiner, and bluntnose minnow. High-gradient Piedmont streams are characterized by cobble-boulder substrates with bedrock outcrops common. Blue Ridge sculpin, brown trout, brook trout, and longnose dace are frequently encountered in these systems. Streamside trees and logs play an important role in shaping the stream channel and banks, creating pools and slow-water areas beneficial to many aquatic species. Logs and leaf litter are also a primary source of organic matter forming the base of the food web in these streams. River basins with Piedmont streams draining into Chesapeake Bay include Susquehanna, Elk, Bush, Gunpowder, Patapsco, the upper portion of the Patuxent River, and the eastern portion of the Potomac Washington Metro basins. There are approximately 2400 miles of Piedmont streams in Maryland.

Location and Condition:

Maryland's Piedmont physiographic province has been the center of urban and suburban development in the state. Stream degradation associated with urbanization has reduced biodiversity and biological health of many Piedmont streams draining urban centers. The overall condition of Piedmont streams on average is fair. Of 261 sites sampled in Piedmont streams from 2000-2004, 39% are severely degraded. Only 15% of the sites sampled in Piedmont streams are considered to be minimally impaired. A predictive model developed by Maryland DNR estimates that, on average, 32% of fish species have been lost from Maryland's Piedmont stream habitats.

Figure 4.26 Location of Piedmont Streams in Maryland (Source: MD DNR MBSS/Versar Inc.)



GCN Species and Other Wildlife:

Reptiles	Silverjaw minnow	Turquoise bluet
Bog turtle	Warmouth	Inverts: Mayflies
Common ribbonsnake	Inverts: Dragonflies & Damselflies	Walker's tusked sprawler
Queen snake	Allegheny river cruiser	Inverts: Beetles
Spotted turtle	Allegheny snaketail	A hydrophilid beetle
Wood turtle	Arrowhead spiketail	Inverts: Freshwater Crustaceans
Amphibians	Brown spiketail	A crayfish
Long-tailed salamander	Cobra clubtail	A crayfish
Northern red salamander	Common sanddragon	An entocytherid ostracod
Fishes	Cyrano darter	An entocytherid ostracod
Bridle shiner	Great spreadwing	Inverts: Freshwater Mussels
Brook trout	Laura's clubtail	Alewife floater
Comely shiner	Least clubtail	Atlantic spike
Glassy darter	Mocha emerald	Brook floater
Greenside darter	Ocellated darter	Creeper
Logperch	Rapids clubtail	Eastern lampmussel
Maryland darter	Royal river cruiser	Green floater
Northern hogsucker	Ski-tailed emerald	Triangle floater
Rosyside dace	Tiger spiketail	Yellow lance
Shield darter		

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, American beaver, muskrat, wood duck, eastern snapping turtle,

brown trout, brook trout, rainbow trout, smallmouth bass, largemouth bass, redbreast sunfish, bluegill, pumpkinseed, longear sunfish, white sucker, yellow bullhead, channel catfish, common carp, rock bass, black crappie, chain pickerel, walleye, golden redhorse, and fallfish. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Stream channelization
- g. Non-native species
- h. Nutrient enrichment
- i. Pesticide/herbicide application that result in pollution or degradation of water quality
- j. Stream blockages, including dams
- k. Loss of headwater areas
- l. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- m. Dumping
- n. Development and land use, including roadways, that result in fragmentation and isolation
- o. Deforestation that results in loss of forested watershed
- p. Human recreation that results in disturbance/degradation
- q. Point-source pollution
- r. Surface mining that result in water quality degradation
- s. Incompatible timber harvesting that result in water quality degradation
- t. Livestock and grazing practices that result in water quality degradation
- u. Urban sprawl/development

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- c. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- d. **Encourage reforestation within watershed** *[Measure: # of acres reforested]*
- e. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- f. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- g. **Implement best management practices for livestock grazing** *[Measure: # of projects implementing BMPs]*
- h. **Cooperate with public on non-point source issues (IPMs) e.g. golf courses, agricultural lands, etc.** *[Measure: # of sites with IMP practices implemented]*
- i. **Upgrade water treatment facilities – separate sewage from runoff (MDE, MES)** *[Measure: # of sites with upgraded treatment]*

- j. Implement low impact development retrofits *[Measure: # of sites with retrofits]*
- k. Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*
- l. Establish passage at existing stream blockages or remove blockages completely where appropriate *[Measure: # of passages established; # of blockages removed]*
- m. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors established]*
- n. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- o. Respond to toxic spills quickly and effectively *[Measure: # of protocols developed and evaluated for effectiveness]*
- p. Work with Army Corps of Engineers and federal, state and county highways to reduce impacts and improve mitigation targeting *[Measure: # of guidelines developed; # of new road plans with guidelines implemented; # of mitigation projects implemented]*
- q. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- r. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- s. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- t. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- u. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with mechanisms to minimize impacts]*
- v. Reforestation of watersheds *[Measure: # of acres reforested]*
- w. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- x. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*

Inventory, Monitoring and Research Needs:

- a. Assess Piedmont stream habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- b. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- c. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- e. Reintroduce certain GCN species into suitable restored habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*

(27) Coastal Plain Streams

Description:

Maryland's coastal plain streams extend from the fall line eastward toward the Atlantic Ocean. These streams are typically low gradient (<1%) and found at elevations of less than 50' above sea level. Silt, sand, gravel, and small cobble are the dominant substrates. Most coastal plain streams contain only runs, glides and pools; however, gravel riffles are common in those streams draining the rolling hills on the western and upper eastern shore.

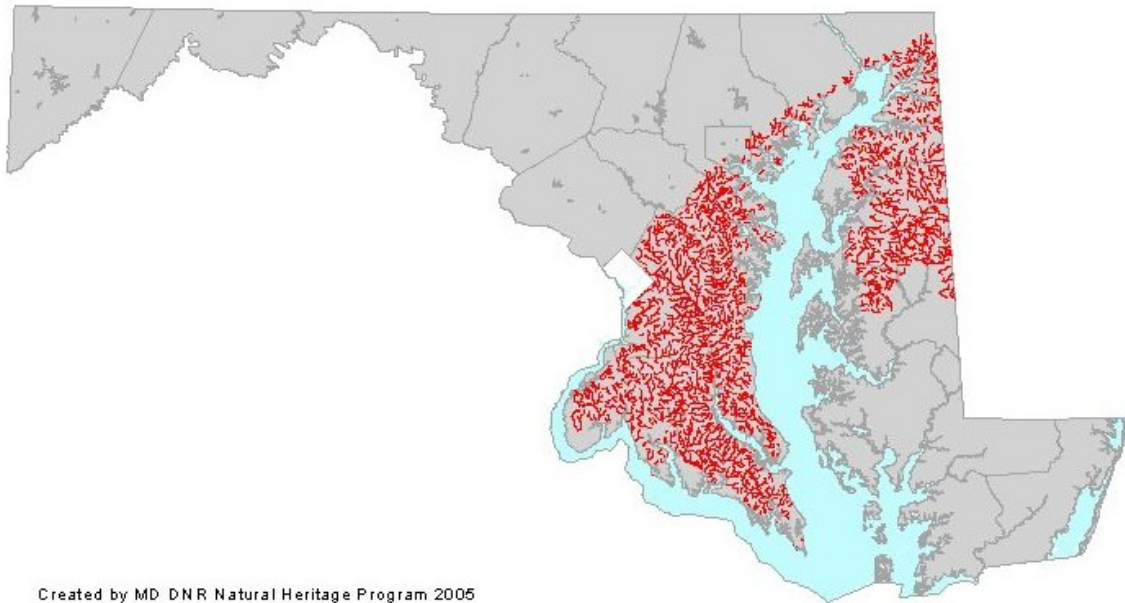


Streams on the lower eastern shore are extremely sluggish with broad floodplains and braided channels. Because coastal plain streams lack stable substrates such as bedrock and boulders, wood and submerged aquatic vegetation are important channel features. Submerged logs and tree roots slow the flow of nutrients and sediment, provide cover for fishes and stream insects, and control stream bank erosion. Eastern mudminnow, golden shiner, creek chubsucker, and fallfish are common in these systems. These streams are also important habitat to the American eel from the juvenile to adult stage. The Chester, Choptank, Nanticoke/Wicomico, Pocomoke, Lower Potomac, Patapsco, Gunpowder, Elk, Lower Susquehanna, Bush, Ocean Coastal, Potomac Washington Metro, West Chesapeake, and Patuxent river basins all contain non-blackwater coastal plain streams, comprising approximately 2500 stream miles.

Location and Condition:

Based on a Combined Biotic Index (CBI) that uses fish and benthic macroinvertebrate communities as indicators of environmental quality, the average condition of Coastal Plain streams in Maryland is fair, meaning that many of these streams are at least partially degraded. Of 287 sites sampled in Coastal Plain streams from 2000-2004, 48% are severely degraded. Only 20% of the sites sampled in Coastal Plain streams are considered to be minimally impaired. A predictive model developed by Maryland DNR estimates that, on average, 54% of fish species have been lost from Maryland's Coastal Plain stream habitats.

Figure 4.27 Location of Coastal Plain Streams in Maryland (Source: MD DNR MBSS/Versar Inc.)



GCN Species and Other Wildlife:

Mammals	Rosyside dace	Sparkling jewelwing
Southeastern star-nosed mole	Shield darter	Tiger spiketail
Reptiles	Silverjaw minnow	Turquoise bluet
Common ribbonsnake	Swamp darter	Uhler's sundragon
Northern red-bellied turtle	Warmouth	Inverts: Beetles
Queen snake	American brook lamprey	Schwarz' diving beetle
Rainbow snake	Least brook lamprey	Inverts: Freshwater Crustaceans
Red-bellied watersnake	Inverts: Dragonflies & Damselflies	A crayfish
Spotted turtle	Allegheny snaketail	Inverts: Freshwater Mussels
Wood turtle	Arrowhead spiketail	Alewife floater
Fishes	Blackwater bluet	Atlantic spike
American shad	Brown spiketail	Creeper
Banded sunfish	Common sanddragon	Dwarf wedge mussel
Blackbanded sunfish	Cyrano darner	Eastern lampmussel
Bluespotted sunfish	Great spreadwing	Eastern pondmussel
Bridle shiner	Laura's clubtail	Northern lance
Brook trout	Least clubtail	Paper pondshell
Flier	Mocha emerald	Tidewater mucket
Glassy darter	Royal river cruiser	Triangle floater
Hickory shad	Russet-tipped clubtail	Yellow lampmussel
Ironcolor shiner	Sable clubtail	Yellow lance
Longnose gar	Selys' sunfly	
Mud sunfish		

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, northern river otter, American beaver, muskrat, mallard, American black duck, wood duck, eastern snapping turtle, largemouth bass, redbreast sunfish, bluegill, pumpkinseed, longear sunfish, white sucker, yellow bullhead, brown bullhead, channel catfish, common carp, yellow perch, white crappie, black crappie, white perch, and chain pickerel. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Non-native species
- g. Nutrient enrichment
- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Loss of headwater areas
- k. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- l. Dumping
- m. Development and land use, including roadways, that result in fragmentation and isolation
- n. Deforestation that results in loss of forested watershed
- o. Human recreation that results in disturbance/degradation
- p. Point-source pollution
- q. Groundwater and stream water withdrawals
- r. Liming practices for agriculture
- s. Stream channelization
- t. Livestock and grazing practices that result in water quality degradation
- u. Inappropriate timber harvest practices that impact water quality or loss of coarse woody debris
- v. Bank erosion
- w. Sea-level rise

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- c. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- d. **Minimize stream channelization** *[Measure: # of stream channelization sites mitigated or eliminated; # miles natural stream flow restored]*
- e. **Maintain and increase forest cover in watersheds** *[Measure: # of acres protected; # of acres reforested]*

- f. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- g. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- h. **Improve sediment and erosion control practices** *[Measure: # of protocols developed; # of sites with management implemented]*
- i. Implement low impact developments, retrofits *[Measure: # of sites with retrofits]*
- j. Implement best management practices for livestock grazing *[Measure: # of projects implementing BMPs]*
- k. Restore ditch streams to natural meanders *[Measure: # of miles natural stream flow restored]*
- l. Utilize Coastal Zone Management programs *[Measure: # of local, state, and federal agency programs incorporating wildlife focused habitat management actions]*
- m. Establish passage at existing stream blockages or remove blockages completely where appropriate *[Measure: # of passages established; # of blockages removed]*
- n. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors established]*
- o. Limit groundwater and stormwater withdrawals *[Measure: # of sites with reduced groundwater/stormwater withdrawals]*
- p. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- q. Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of acres habitat managed for GCN species]*
- r. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- s. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- t. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- u. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- v. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with mechanisms to minimize impacts]*
- w. Reforestation of watersheds *[Measure: # of acres reforested]*
- x. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- y. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*
- z. Conserve and restore associated wetland areas *[Measure: # of acres conserved, # of acres restored]*

Inventory, Monitoring and Research Needs:

- a. Assess Coastal Plain stream habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- b. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- c. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology,

demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*

- e. Reintroduce certain GCN species, including freshwater mussels, into suitable habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*
- f. Determine which watersheds are most suitable for reintroducing GCN fish species *[Measure: # of sites/watersheds evaluated for reintroduction]*

(28) Blackwater Streams

Description:

Blackwater streams are sluggish, low gradient (<1%) systems located within the Pocomoke and Nanticoke/Wicomico basins of Maryland's Coastal Plain physiographic province. They are characterized by low acidity, generally with pH levels less than 6, and dissolved organic carbon greater than 8 mg/L. In contrast to clearwater streams, dissolved oxygen levels are low (< 5mg/L) due to increased bacterial respiration from the decomposition

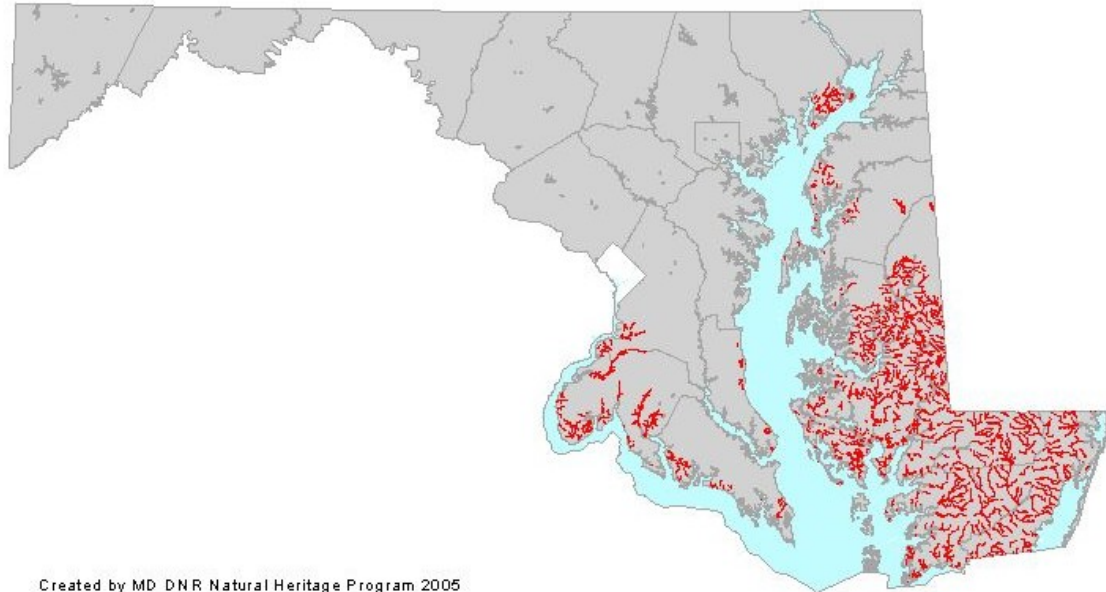


of organic matter. Substrate consists primarily of silt, sand, and organic matter, with minor and isolated amounts of small gravel. Because of the lack of larger, more stable substrate, instream wood is of critical importance in defining hydrologic features and providing cover for the aquatic biota. Biodiversity in blackwater streams is typically low, and limited to only those organisms that are tolerant of the naturally acidic conditions. Common fishes include eastern mudminnow, pirate perch, creek chubsucker, tadpole madtom, and redbfin pickerel. The benthic macroinvertebrate community is dominated by true fly, dragonfly, amphipod and isopod taxa. Blackwater systems comprise approximately 1200 miles of Maryland streams.

Location and Condition:

Centuries of intensive agricultural practices and stream channelization have reduced the extent of blackwater streams on Maryland's Coastal Plain. Based on geologic, soil, stream gradient, and elevation data in Maryland's Coastal Plain, approximately 1200 miles of streams are designated blackwater stream habitats. However, streamside logging, stream channelization, and agricultural liming practices have altered many of these stream miles such that these streams no longer possess the chemical properties (i.e., dissolved organic carbon >8 mg/L; pH < 6.0; dissolved oxygen <5 mg/L) attributed to blackwater habitats. Of the 142 sites sampled within the blackwater stream habitats, only 37 % are in true blackwater streams. The remaining 63% of the sites no longer maintain high concentrations of organic carbon, low dissolved oxygen, and low pH waters, criteria used by the Maryland DNR to define blackwater streams. Significantly lower forested land cover upstream of these sites than found above true blackwater sites likely contributes to lower organic carbon concentrations. A predictive model developed by Maryland DNR estimates that, on average, 47% of fish species have been lost from Maryland's blackwater stream habitats.

Figure 4.28 Location of Blackwater Streams in Maryland (Source: MD DNR MBSS/Versar Inc.)



GCN Species and Other Wildlife:

Mammals	Glassy darter	Russet-tipped clubtail
Southeastern star-nosed mole	Ironcolor shiner	Sparkling jewelwing
Reptiles	Longnose gar	Turquoise bluet
Common ribbonsnake	Mud sunfish	Inverts: Freshwater Mussels
Northern red-bellied turtle	Silverjaw minnow	Alewife floater
Red-bellied watersnake	Swamp darter	Dwarf wedge mussel
Spotted turtle	Least brook lamprey	Eastern lampmussel
Fishes	Inverts: Dragonflies & Damselflies	Eastern pondmussel
Banded sunfish	Blackwater bluet	Northern lance
Blackbanded sunfish	Cyrano darter	
Bluespotted sunfish	Mocha emerald	
Bridle shiner	Royal river cruiser	
Flier		

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, northern river otter, American beaver, muskrat, mallard, American black duck, wood duck, eastern snapping turtle, largemouth bass, bluegill, yellow bullhead, common carp, yellow perch, white crappie, black crappie, white perch, and chain pickerel. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- Urban land use and impervious surface that result in chemical and hydrologic changes

- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Loss of headwater streams
- g. Non-native species
- h. Nutrient enrichment
- i. Pesticide/herbicide application that result in pollution or degradation of water quality
- j. Stream blockages, including dams
- k. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- l. Dumping
- m. Development and land use, including roadways, that result in fragmentation and isolation
- n. Deforestation that results in loss of forested watershed
- o. Human recreation that results in disturbance/degradation
- p. Point-source pollution
- q. Groundwater and stream water withdrawals
- r. Liming practices that result in water quality degradation
- s. Stream channelization
- t. Incompatible timber harvest practices that impact water quality or result in the loss of coarse woody debris

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- c. **Maintain and increase forest cover in watersheds** *[Measure: # of acres protected; # of acres reforested]*
- d. **Minimize stream channelization** *[Measure: # of stream channelization sites mitigated or eliminated; # miles natural stream flow restored]*
- e. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- f. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- g. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- h. **Establish passage at existing stream blockages or remove blockages completely where appropriate** *[Measure: # of passages established; # of blockages removed]*
- i. **Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such** *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*
- j. **Utilize Coastal Zone Management programs** *[Measure: # of local, state, and federal agency programs incorporating wildlife focused habitat management actions]*
- k. **Implement best management practices for liming application** *[Measure: # of projects implementing BMPs]*
- l. **Limit groundwater and surface water withdrawals** *[Measure: # of sites with reduced groundwater/stormwater withdrawals]*

- m. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors established]*
- n. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- o. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- p. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- q. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- r. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- s. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with mechanisms to minimize impacts]*
- t. Reforestation of watersheds *[Measure: # of acres reforested]*
- u. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- v. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*
- w. Conserve and restore associated wetland areas *[Measure: # of acres conserved, # of acres restored]*

Inventory, Monitoring and Research Needs:

- a. Define the complete extent of distribution of blackwater stream habitats *[Measure: distribution of blackwater streams updated; habitat model developed and assessed]*
- b. Assess blackwater stream habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- c. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- d. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- e. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- f. Reintroduce certain GCN species into suitable habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*

(29) Highland Rivers

Description:

Large Highland rivers in Maryland are located in the western portion of the state in the Youghiogheny and Potomac River basins. Highland rivers consist of riffle/run and pool habitat sequences with substrate ranging from large boulders to sand and silt. The energy base for these systems includes large woody debris and leaf litter, as well as primary production by periphyton, phytoplankton, and aquatic macrophytes.



Game fish species common to Highland rivers include smallmouth bass, chain pickerel, and walleye. Tiger muskellunge, northern pike, walleye, brown trout, rainbow trout, and cutthroat trout are gamefish stocked in Highland rivers. Non-game species common in these systems include American eel, redbreast sunfish, rockbass, Potomac sculpin, Northern hogsucker, and stonecat. There are approximately 130 miles of Highland riverine habitat in Maryland.

Location and Condition:

Degradation and loss of species associated with highland and coldwater tributaries have ultimately affected the downstream conditions of Maryland's highland riverine habitats. Highland rivers serve as receiving waters for effluents from industrial sources and municipal sewage treatment plants. The damming of highland rivers for drinking water reservoirs and hydroelectric power generation has altered these habitats considerably, often reducing available habitats for many GCN fish and mussel species. Although these rivers provide excellent recreational opportunities, the introduction of non-native gamefish has been extensive and has altered the natural community composition of these habitats.

Figure 4.29 Location of Highland Rivers in Maryland (Sources: MD DNR MBSS/Versar Inc.; MD DNR NHP)



GCN Species and Other Wildlife:

Birds	Silverjaw minnow	Rusty snaketail
Bald eagle	Stonecat	Spine-crowned clubtail
Common loon	Striped shiner	Splendid clubtail
Horned grebe	Warmouth	Stygian shadowdragon
Reptiles	Inverts: Dragonflies & Damselflies	Inverts: Mayflies
Eastern spiny softshell	A snaketail	Walker's tusked sprawler
Northern red-bellied turtle	Allegheny river cruiser	Inverts: Freshwater Mussels
Spotted turtle	Cobra clubtail	Alewife floater
Amphibians	Cyrano darner	Atlantic spike
Common mudpuppy	Eastern ringtail	Brook floater
Eastern hellbender	Elusive clubtail	Creeper
Fishes	Green-faced clubtail	Eastern lampmussel
Cheat minnow	Laura's clubtail	Green floater
Comely shiner	Least clubtail	Paper pondshell
Greenside darter	Midland clubtail	Tidewater mucket
Johnny darter	Ocellated darner	Triangle floater
Longnose sucker	Rapids clubtail	Yellow lampmussel
Northern hogsucker		

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, northern river otter, American beaver, muskrat, Canada goose, mallard, American black duck, wood duck, ring-necked duck, common merganser, hooded

merganser, eastern snapping turtle, brook trout, brown trout, rainbow trout, cutthroat trout, smallmouth bass, largemouth bass, rock bass, redbreast sunfish, bluegill, pumpkinseed, longear sunfish, white sucker, yellow bullhead, brown bullhead, channel catfish, common carp, yellow perch, black crappie, walleye, muskellunge, fallfish, golden redhorse, and shorthead redhorse. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Non-native species
- g. Nutrient enrichment
- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- k. Dumping
- l. Development and land use, including roadways, that result in fragmentation and isolation
- m. Deforestation that results in loss of forested watershed
- n. Human recreation that results in disturbance/degradation
- o. Point-source pollution
- p. Acid mine drainage
- q. Hydroelectric power generation
- r. Incompatible timber harvest practices that impact water quality

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- c. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- d. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- e. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- f. **Minimize and mitigate acid mine drainage damage to rivers** *[Measure: # of guidelines and protocols developed; # of sites with protocols implemented]*
- g. **Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such** *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*
- h. **Establish passage at existing stream blockages or remove blockages completely where appropriate** *[Measure: # of passages established; # of blockages removed]*
- i. **Preserve and enhance connectivity of critical habitats** *[Measure: # of existing watersheds connected by new corridors established]*

- j. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- k. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- l. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- m. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- n. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- o. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with comments/input to minimize impacts]*
- p. Reforestation of watersheds *[Measure: # of acres reforested]*
- q. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- r. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*

Inventory, Monitoring and Research Needs:

- a. Assess highland river habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- b. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- c. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- e. Reintroduce certain GCN species into suitable habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*

(30) Piedmont Rivers

Description:

Large rivers of the Piedmont physiographic province are transition habitats between headwater streams and tidal portions of Chesapeake Bay. Physically, Piedmont rivers consist of large riffle/run and pool sequences with substrate ranging from large boulders to sand and silt. As transition zones between upland habitats and lowlands of the Coastal Plain, Piedmont rivers are home to



a diverse aquatic fauna, often consisting of a mixture of piedmont and lowland species. Chemical, physical, and hydrologic stability typical of large Piedmont rivers also contribute to high species diversity. Fish species common to Piedmont rivers include American eel, river chub, spottail shiner, common shiner, white sucker, smallmouth bass, largemouth bass, pumpkinseed, redbreast sunfish, bluegill, rockbass, and margined madtom. Piedmont rivers provide spawning habitat to many migratory fish species of Chesapeake Bay such as blueback herring, alewife, white perch, yellow perch, striped bass, and several species of shad. Piedmont rivers also serve as wintering habitats for migratory waterfowl. Although logs and leaf litter continue to play a large role in the food base of these systems, open tree canopies allow for the growth of periphyton, phytoplankton, and aquatic macrophytes providing additional sources of energy to the food chain. Connectivity between river channels and the adjacent floodplain is important for the movement and exchange of organic matter in these systems. Floodplains also provide refugia for aquatic species during periods of high flows. Piedmont riverine habitat can be found in portions of the Susquehanna, Elk, Bush, Gunpowder, Patapsco, the upper portion of the Patuxent River, and the eastern portion of the Potomac Washington Metro basins. There are approximately 240 miles of Piedmont riverine habitat in these basins.

Location and Condition:

Piedmont rivers are located in highly urbanized portions of Maryland. Stressors associated with urbanization have had negative affects on these habitats. Combined sewer overflows (CSOs) designed to carry domestic, commercial, and industrial wastewater often deliver untreated sewage to Piedmont rivers during storm flows. These outflows can reduce biological health of these habitats. As with highland rivers, Piedmont rivers have been impounded for drinking water reservoirs and for hydroelectric power generation. Impoundments have reduced the available habitat for several GCN fish and mussel species and also reduced upstream access to spawning grounds by many migratory fishes. Degradation of Piedmont and coldwater tributaries has negatively affected downstream Piedmont rivers.

Figure 4.30 Location of Piedmont Rivers in Maryland (Source: MD DNR MBSS/Versar Inc.; MD DNR NHP)



GCN Species and Other Wildlife:

Birds	Shield darter	Royal river cruiser
Bald eagle	Silverjaw minnow	Russet-tipped clubtail
Common loon	Trout-perch	Rusty snaketail
Horned grebe	Warmouth	Skillet clubtail
Reptiles	White catfish	Smoky rubyspot
Northern map turtle	Inverts: Dragonflies & Damselflies	Spine-crowned clubtail
Northern red-bellied turtle	Allegheny river cruiser	Splendid clubtail
Rainbow snake	Allegheny snaketail	Stygian shadowdragon
Spotted turtle	Big bluet	Inverts: Freshwater Mussels
Wood turtle	Cobra clubtail	Alewife floater
Amphibians	Common sanddragon	Atlantic spike
Eastern hellbender	Cyrano darner	Brook floater
Fishes	Eastern ringtail	Creeper
American shad	Elusive clubtail	Dwarf wedge mussel
Bowfin	Laura's clubtail	Eastern lampmussel
Bridle shiner	Least clubtail	Green floater
Comely shiner	Midland clubtail	Paper pondshell
Greenside darter	Ocellated darner	Tidewater mucket
Hickory shad	Rapids clubtail	Triangle floater
Logperch	Riverine clubtail	Yellow lampmussel
Northern hogsucker	Robust baskettail	Yellow lance

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, American beaver, muskrat, Canada goose, mallard, wood duck, ring-necked duck, common merganser, hooded merganser, eastern snapping turtle, smallmouth bass, largemouth bass, redbreast sunfish, bluegill, pumpkinseed, longear sunfish, white sucker, yellow bullhead, channel catfish, common carp, yellow perch, black crappie, chain pickerel, walleye, muskellunge, fallfish, golden redhorse, shorthead redhorse, rock bass, green sunfish, and brown bullhead. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Non-native species
- g. Nutrient enrichment
- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- k. Dumping
- l. Development and land use, including roadways, that result in fragmentation and isolation
- m. Deforestation that results in loss of forested watershed
- n. Human recreation that results in disturbance/degradation
- o. Point-source pollution
- p. Incompatible timber harvest practices that impact water quality
- q. Hydroelectric power generation

Conservation Actions:

- a. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- b. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- c. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- d. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- e. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- f. **Enhance point-source pollution control** *[Measure: # of protocols implemented to control point-source pollution; # of miles protected by implementation]*
- g. **Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such** *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*

- h. Work with Army Corps of Engineers and federal, state and county highways to reduce impacts and improve mitigation targeting *[Measure: # of guidelines developed; # of new road plans with guidelines implemented; # of mitigation projects implemented]*
- i. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- j. Establish passage at existing stream blockages or remove blockages completely where appropriate *[Measure: # of passages established; # of blockages removed]*
- k. Preserve and enhance connectivity of critical habitats *[Measure: # of existing watersheds connected by new corridors established]*
- l. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- m. Work with power companies to address thermal pollution from hydroelectric power generation *[Measure: # of guidelines developed; # of projects implemented; # of miles protected by implementation of guidelines]*
- n. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- o. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- p. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- q. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with comments/input to minimize impacts]*
- r. Reforestation of watersheds *[Measure: # of acres reforested]*
- s. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- t. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*

Inventory, Monitoring and Research Needs:

- a. Assess Piedmont river habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- b. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- c. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- e. Reintroduce certain GCN species into suitable habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*
- f. Develop a Maryland Biological River Survey *[Measure: development of Maryland Biological River Survey]*

(31) Coastal Plain Rivers

Description:

Large Coastal Plain rivers consist of predominately pool/glide habitat with sand and silt substrates. Large woody debris is an important element in structuring pool habitat and serves as an important source of coarse organic matter to riverine food webs. Open tree canopies allow for the growth of periphyton, phytoplankton, and aquatic macrophytes. These primary producers also form the base of energy flow within these systems.



Connectivity between river channels and the adjacent floodplain is important for the movement and exchange of organic matter in Coastal Plain river systems. Floodplains provide refugia for aquatic species during periods of high flows, and refugia for prey species from main channel fish predators. Extensive pool habitat common in Coastal Plain rivers is home to many large predator fish species typically uncommon in headwater Coastal Plain streams. Fish species common to Coastal Plain rivers include largemouth bass, chain pickerel, pumpkinseed, redbreast sunfish, black crappie, bluegill, fallfish, shorthead redhorse, longnose gar, and warmouth. Coastal Plain rivers also provide spawning habitat to many migratory fish species of Chesapeake Bay such as blueback herring, alewife, white perch, yellow perch, American shad, and hickory shad. Sandy substrates of Coastal Plain rivers support a diverse community of freshwater mussels (Unionidae); many of which are rare, threatened, or endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. Coastal Plain rivers also serve as wintering habitats for migratory waterfowl. Coastal Plain riverine habitat can be found in portions of the Elk, Chester, Choptank, Nanticoke, Lower Potomac, Patuxent, Pocomoke, and Wicomico river basins. Coastal Plain riverine habitat comprises approximately 100 stream miles within these basins.

Location and Condition:

Degradation and loss of species associated with Coastal Plain and blackwater tributaries have ultimately affected the downstream conditions of Maryland's Coastal Plain riverine habitats. Maryland Coastal Plain rivers are located in predominately agricultural watersheds. Nutrient enrichment and sedimentation associated with agricultural land use practices have reduced habitat quality and quantity available to many GCN fish and mussel species. Stream blockages have also reduced upstream access to spawning habitats by migratory fishes.

Figure 4.31 Location of Coastal Plain Rivers in Maryland (Source: MD DNR MBSS/Versar Inc.; MD DNR NHP)



GCN Species and Other Wildlife:

Mammals	Bowfin	Piedmont clubtail
Southeastern star-nosed mole	Bridle shiner	Royal river cruiser
Birds	Comely shiner	Russet-tipped clubtail
American black duck	Hickory shad	Smoky rubyspot
Bald eagle	Logperch	Inverts: Freshwater Mussels
Common loon	Longnose gar	Alewife floater
Horned grebe	Stripeback darter	Atlantic spike
Reptiles	Warmouth	Creepers
Northern red-bellied turtle	White catfish	Eastern lampmussel
Rainbow snake	Inverts: Dragonflies & Damselflies	Eastern pondmussel
Red-bellied watersnake	Allegheny snaketail	Northern lance
Spotted turtle	Big bluet	Paper pondshell
Wood turtle	Common sanddragon	Tidewater mucket
Fishes	Cyrano darter	Yellow lampmussel
American shad	Laura's clubtail	Yellow lance
Bluespotted sunfish		

In addition to the GCN species listed above, this key wildlife habitat supports a wide diversity of wildlife species. The following game species are found in this habitat type: common raccoon, mink, northern river otter, American beaver, muskrat, Canada goose, mallard, American black duck, wood duck, ring-necked duck, hooded merganser, snapping turtle, largemouth bass, bluegill, pumpkinseed, redbreast sunfish, channel catfish, white catfish, yellow bullhead, brown bullhead, common carp, white perch, yellow perch, chain

pickerel, striped bass, blueback herring, and alewife. Management plans and conservation programs for these game species are currently being implemented by MD DNR, USFWS, and many other partners.

Threats:

- a. Urban land use and impervious surface that result in chemical and hydrologic changes
- b. Sedimentation
- c. Removal or degradation of riparian buffers
- d. Atmospheric deposition
- e. Fragmentation, degradation, and loss of habitats
- f. Non-native species
- g. Nutrient enrichment
- h. Pesticide/herbicide application that result in pollution or degradation of water quality
- i. Stream blockages, including dams
- j. Lack of scientific understanding of appropriate habitat requirements and management for all GCN species
- k. Dumping
- l. Development and land use, including roadways, that result in fragmentation and isolation
- m. Deforestation that results in loss of forested watershed
- n. Human recreation that results in disturbance/degradation
- o. Point-source pollution
- p. Incompatible timber harvest practices that impact water quality
- q. Oil and chemical spills
- r. Excessive human recreational use that results in habitat degradation

Conservation Actions:

- a. **Maintain and increase forest cover in watersheds** *[Measure: # of acres protected; # of acres reforested]*
- b. **Restore and protect riparian buffers** *[Measure: # of miles of buffers conserved]*
- c. **Limit impervious surfaces in watersheds** *[Measure: % of impervious surfaces within watershed]*
- d. **Improve stormwater management** *[Measure: # of stormwater control guidelines developed; # of guidelines incorporated into local, state, and federal agency plans]*
- e. **Work with watershed management plans to conserve streams and rivers** *[Measure: # of watersheds with cooperative management projects]*
- f. **Develop land management plans which incorporate conservation measures into the local planning processes** *[Measure: # of local, state, and federal agency plans incorporating wildlife focused habitat management actions]*
- g. **Develop habitat buffer guidelines for use by foresters and land managers and work with them to implement such** *[Measure: # of guidelines developed; # of sites with cooperative management projects; # of miles of habitat managed for GCN species]*
- h. **Utilize Coastal Zone Management programs** *[Measure: # of local, state, and federal agency programs incorporating wildlife focused habitat management actions]*
- i. **Establish passage at existing stream blockages or remove blockages completely where appropriate** *[Measure: # of passages established; # of blockages removed]*
- j. **Preserve and enhance connectivity of critical habitats** *[Measure: # of existing watersheds connected by new corridors established]*

- k. Work with Army Corps of Engineers and federal, state and county highways to reduce impacts and improve mitigation targeting *[Measure: # of guidelines developed; # of new road plans with guidelines implemented; # of mitigation projects implemented]*
- l. Respond to oil and chemical spills quickly and effectively *[Measure: # of protocols developed and evaluated for effectiveness; # of immediate responses]*
- m. Develop and implement protocols to control invasive species *[Measure: # of protocols developed; # of sites with management implemented]*
- n. Implement best management practices for nutrient and pesticide application *[Measure: # of projects implementing BMPs]*
- o. Implement soil conservation *[Measure: # of projects implementing BMPs]*
- p. Educate the public regarding necessary conservation of streams and rivers and their GCN species *[Measure: # of educational materials developed and distributed]*
- q. Reduce trash dumping and fishing line dumping by educating the public *[Measure: # of educational materials developed and distributed]*
- r. Work with Maryland DOT to improve transportation planning for new roads to minimize impacts to habitat *[Measure: # of new road plans with comments/input to minimize impacts]*
- s. Reforestation of watersheds *[Measure: # of acres reforested]*
- t. Limit recreational activities to protect resources *[Measure: # of sites with limited access]*
- u. Coordinate conservation efforts between various interest groups and across states boundaries, including state agencies *[Measure: # of cooperative projects implemented]*

Inventory, Monitoring and Research Needs:

- a. Assess Coastal Plain river habitat condition and prioritize for conservation *[Measure: # of assessments completed; # of conservation actions modified and re-prioritized based on assessment]*
- b. Survey unexplored areas with potential GCN species habitats *[Measure: # of surveys completed]*
- c. Monitor existing GCN species populations so that widespread declines can be detected *[Measure: # of monitoring studies established; # of monitoring studies conducted]*
- d. Develop more complete understanding of GCN species habitat requirements, life history, minimum viable population size, distribution, abundance, ecology, demographics and recruitment *[Measure: # of research projects conducted; # of research papers published]*
- e. Reintroduce certain GCN species into suitable habitats where appropriate *[Measure: # of sites with reintroduction implemented; # of viable populations established]*
- f. Periodically monitor for the presence of spawning migratory fish *[Measure: # of surveys completed]*

